Lifecycle Management of Learning Objectives for SCORM 2.0

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ABSTRACT

Although reusability and repurposing of learning content are inherent expectations of the Sharable Content Object Reference Model (SCORM), they are tenets that have often proven difficult for organizations to actually achieve. SCORM 2004 content provides that mapped objectives are global to the learning system by default. Without a well-defined development and life cycle management strategy for learning objectives, this may lead to unintentional outcomes that could negatively impact both the delivery and reusability of the content.

In 2003, the US Navy embarked on an ambitious journey to convert much of their traditional instructor-led training to SCORM-conformant web-based training. As a result, the Navy recognized the importance of identifying and managing content objects and their associated learning objectives from the initial stage of development.

This white paper provides a background and summary of the Navy's experiences with implementing a content planning system to address the life cycle management of learning objectives, and further proposes the creation of a learning objective specification as part of SCORM 2.0, but not necessarily as part of the Core SCORM. The need for a learning objective specification does not apply to simple SCORM content that does not impose a structured instructional strategy or composition. This white paper will briefly cover the technical and process-related solutions an organization could use to successfully manage learning objectives associated with multiple content objects across an entire organization's training portfolio.

PROBLEM DEFINITION

Any organization that develops large amounts of learning content must have a business process and a capability to uniquely identify and effectively manage that content. This critical aspect of maintenance and configuration control also applies to and should be tightly integrated with the learning objectives associated with the content, especially if the organizational goal is for the learner to ultimately receive a competency-based learning experience (Ostyn, 2005).

When implementing objectives in a SCORM 2004 (n.d.) content package, several technical concerns arise, but are currently "outside the scope" of SCORM:

1. Applying truly unique identifiers to objectives are necessary so that a SCORM Run-Time Service **(RTS) won't unintentionally force an "objective collision".** This "objective collision" is the result of two structurally different objectives sharing the same identifier in two different content packages. Therefore, an objective associated with a SCO in one content package will inadvertently satisfy the same objective in another content package. Many SCORM content developers that use mapped objectives don't realize that they are *Global To System* (SCORM 2004) by default. It is not uncommon for content developers to use a generic naming convention when creating identifiers because they often use objective identifiers as variables in their strategy for sequencing their Sharable Content Objects (SCOs). For example, SCO #1 in manifest #1 has an objective identifier of "global_obj" and SCO #1 in a manifest #2 also references the same objective identifier of "global_obj". If a learner satisfies either one of these SCOs, the other SCO will also be displayed as satisfied to the learner. SCORM 2.0 should more directly address how objectives can be managed and further provide a specification that addresses the assignment and enforcement of unique identifiers to prevent objective collisions. A visual representation and use case will illustrate this issue later in the paper.

2. The lack of a specification for learning objectives negatively impacts reusability and might even contribute to redundant content development efforts. Subject matter that might satisfy a learning objective in one course or content package has the potential to be duplicated in another. In other words, large organizations may unintentionally develop new content that is mapped to a specific learning objective without knowing that a prior content development effort already addressed the same learning objective. SCORM 2.0 should address the management of learning objectives and consider their role in the front-end analysis stage of content development to ultimately reduce waste and increase the potential for reusability.

3. A major issue with SCORM 2004 is that it does not place any restrictions on how learning objectives are associated with learning activities nor does it explicitly define how content objects should use learning objectives. Relevant information about a learning objective should be provided as part of the SCORM content package. A new, supporting specification and XML binding could be created that would be similar to how Learning Object Metadata (LOM) is used to describe basic information about the content. The elements of that supporting specification and XML binding will be described later in the white paper.

STAKEHOLDERS

This problem affects a wide range of stakeholders in the Navy with which the authors are familiar. Stakeholders include:

- Content Developers
- Instructional Systems Designers
- Fleet Training Specialists
- Curriculum and Instruction Support Offices
- Learning Centers
- Systems Commands (Navy acquisition activities)
- Human Performance Specialists

- Learning Management Coordinators
- Learners
- Operational Units

EXAMPLE USE CASE

This use case will focus on a problem the US Navy encountered with objective collisions, and how the problem could be partially resolved by employing a life cycle management strategy for learning objectives. The remaining aspects of the problem could be resolved by incorporating a new specification to fully support and define learning objectives and their role in SCORM 2.0.

Since the Navy first implemented SCORM 2004, a recurring situation has been encountered where several unique content aggregations (manifests) have been created by different content developers, but the content shares the same objective identifiers. This commonly happens because content developers are using generic naming conventions for their identifiers so they can easily recognize them as variables in their sequencing strategy when assembling a quick wire-frame design. The content developer does not often remove or update the generic naming convention, and in turn, does not alter the default rule that objectives are global to the learning system (e.g. LMS). To demonstrate this use case, a series of screen captures will be provided to demonstrate this unintentional "objective collision". The screen captures will follow in ascending order:

SCREEN 1 DESCRIPTION: Navy eLearning Enrollments Screen. Learner has enrolled in, but has not attempted either of these catalog items.

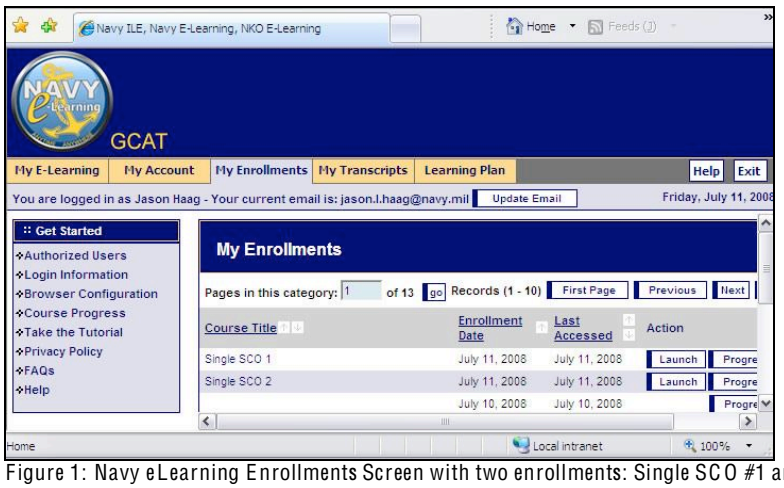

Figure 1: Navy eLearning Enrollments Screen with two enrollments: Single SCO #1 and Single SCO #2.

SCREEN 2 DESCRIPTION: Manifest Comparison for each of these catalog items. Notice that these two manifests have titles and identifiers that differ in all aspects except for the objective identifier. The Single SCO #1 manifest has an objective identifier of "global_obj" and the Single SCO # 2 manifest also has an objective identifier of "global_obj". It is not uncommon for content developers to use a generic naming convention when creating identifiers because it makes it easier to test and scope out their sequencing strategy.

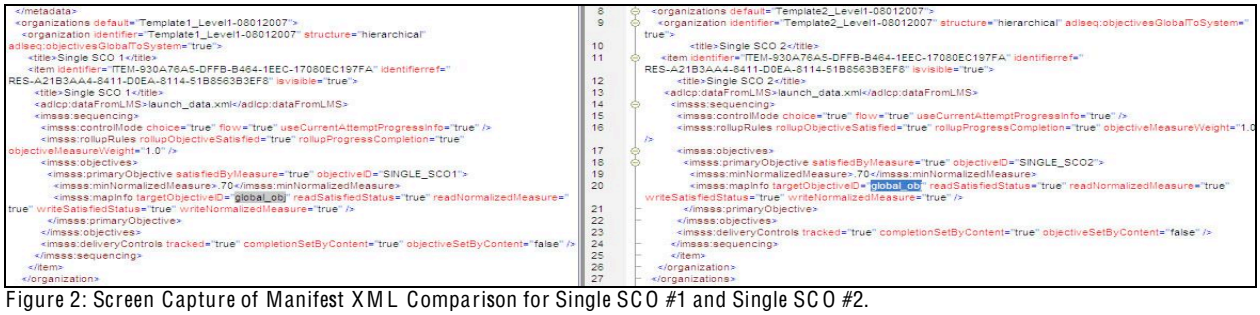

Figure 2: Screen Capture of Manifest XML Comparison for Single SCO #1 and Single SCO #2.

SCREEN 3 DESCRIPTION: The screen capture below demonstrates the visual progress indicator for the SCO (empty circle) before an attempt has been made on the SCO. Once the course has been attempted, then the circle changes to half full.

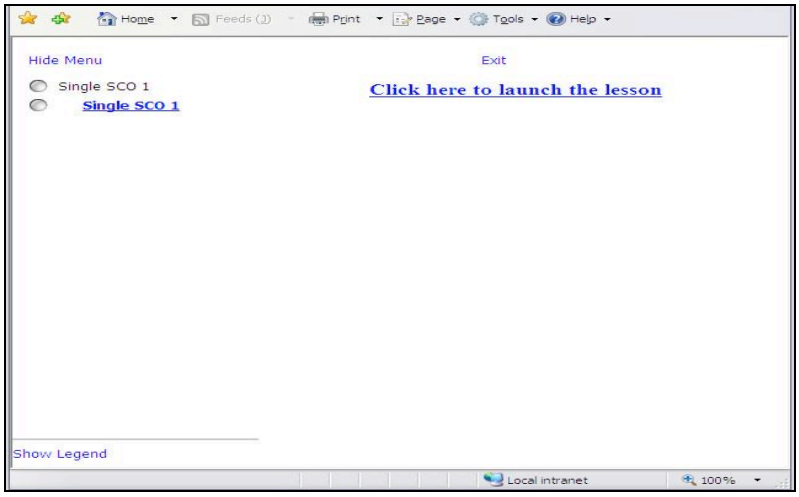

Figure 3: Screen Capture of Launching the Single SCO #1 Course Menu (aka Manifest/Activity Tree Rendering).

SCREEN 4 DESCRIPTION: After clicking the Launch link as shown in Figure 3, the learner attempts the SCO (the interface is of a tester course) and sets the appropriate cmi data model elements. With this example course, the Navy expedites testing a particular sequencing strategy or other intended instructional aspect of the course (scoring and rollup). For this use case, the scaled score is set to 0.7 and the success status is set to "passed". This will satisfy the learning objective for the SCO and the associated learning objective identifier will be globally "satisfied" in the LMS.

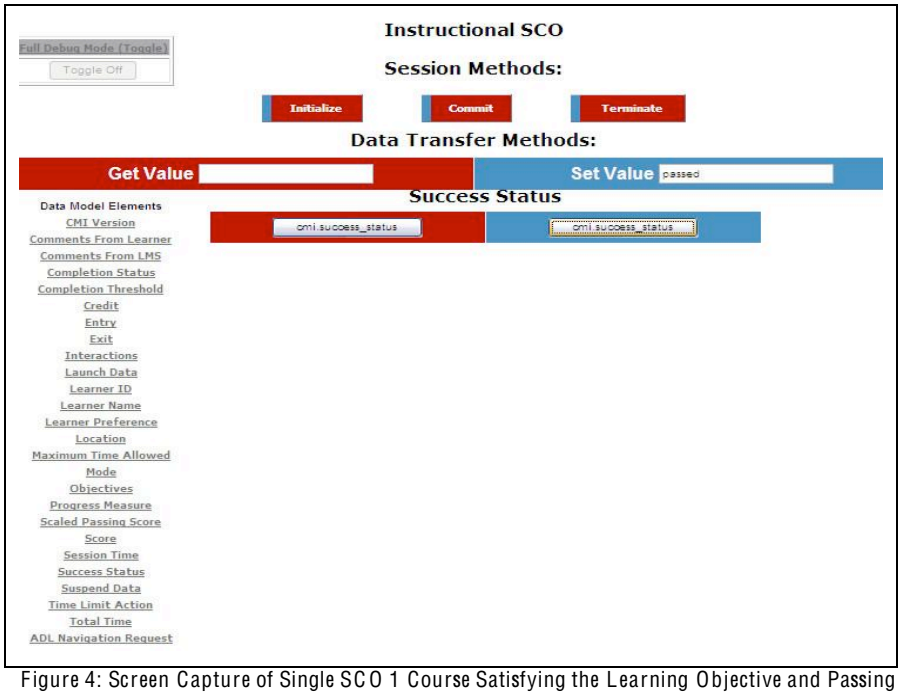

Figure 4: Screen Capture of Single SCO 1 Course Satisfying the Learning Objective and Passing

SCREEN 5 DESCRIPTION: Once the Single SCO #1 Course has been exited the learner is immediately taken to the activity tree menu and the visual progress indicator updates to a green filled circle indicating "passed" or "satisfied".

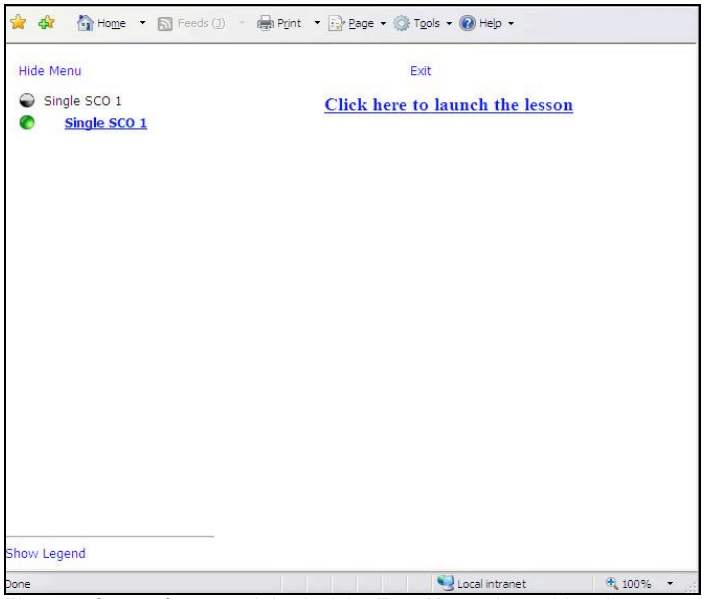

Figure 5: Screen Capture of the Activity Tree Menu after exiting the course

SCREEN 6 DESCRIPTION: The Single SCO #1 course has rolled up and become a transcript for the learner. Next the Single SCO# 2 course will be launched from Enrollments.

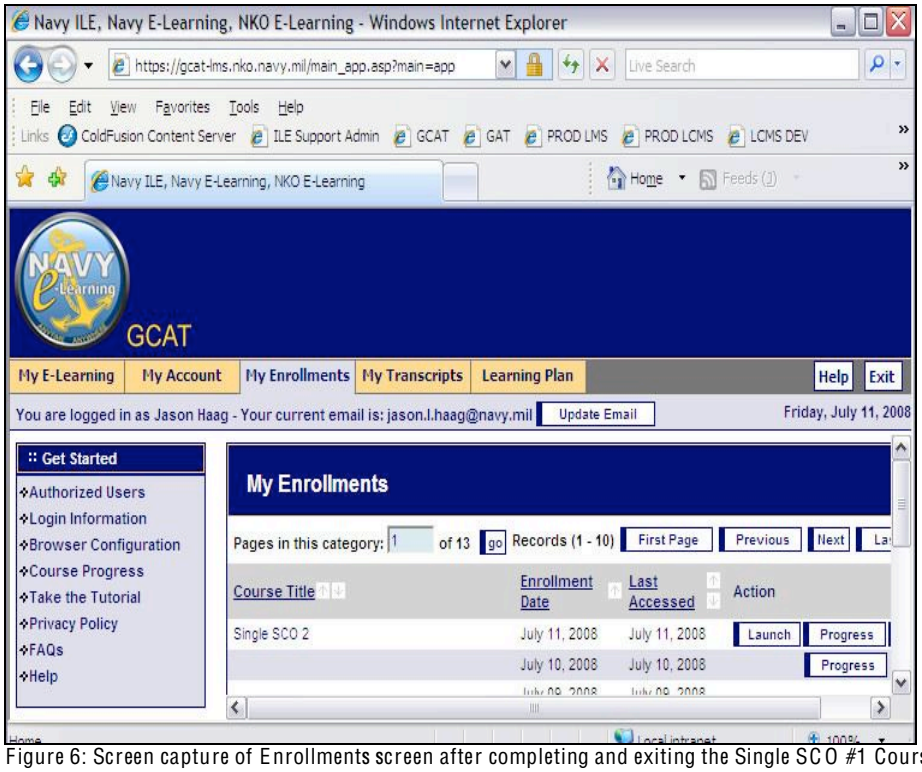

Figure 6: Screen capture of Enrollments screen after completing and exiting the Single SCO #1 Course.

SCREEN 7 DESCRIPTION: Without even attempting the Single SCO #2 course it can be seen that the activity menu tree already displays a green-filled circle. This is by design of SCORM (competency-based objectives), but in this scenario it accidentally happened because the content developers for both of these courses used the same mapped global objective generically named "global_obj".

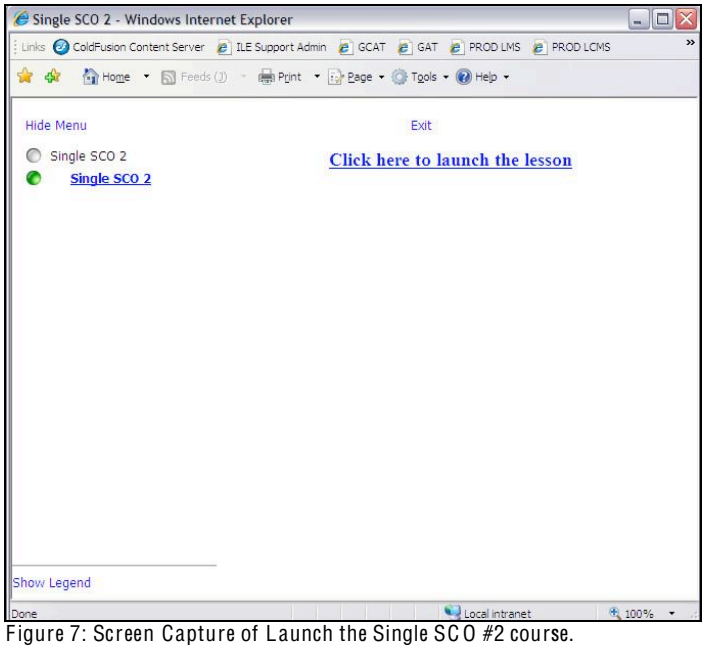

Figure 7: Screen Capture of Launch the Single SCO #2 course.

PROPOSED SOLUTION

Solving the problem with the aforementioned use case would involve a versioning and configuration control component for the identification and management of each learning objective. Versioning and configuration control is essential to the life cycle maintenance of learning objectives as content is reused, repurposed, and distributed throughout an organization or across similar learning communities of interest (e.g. Department of Defense). Conceptually, the solution would require that the unique identifier for a specific version of an objective is associated to the content object by using a persistent identifier. This is important so that one version of an objective can be mapped to a previous version throughout the lifecycle of the learning objective. Currently, the Navy is using this approach in their versioning and configuration control of learning objectives by assigning a persistent identifier to each learning objective. As each version of a learning objective is developed, it is assigned a unique identifier. In the SCORM package, the versioned learning objective is referenced by its unique identifier, while metadata tagging provides the information that the versioned learning objective is a version of the learning objective's persistent identifier. An example is shown in the table below.

Objective Unique Identifier	Is a Version of Persistent Identifier	Lifecycle Version of Objective	Objective Text
101	100	1	Explain how SCOs are used in a SCORM 2004 package.
102	100	2	Explain how SCOs are used in a SCORM 2.0 package.

Table 1: Global Identifiers would typically be 32 character identifiers but are simplified here for illustrative purposes.

Providing support for versioning and configuration control of the learning objective would only cover part of the total solution. The other part of the solution would involve creating a new specification and XML binding as part of SCORM 2.0 to further support the utility of the learning objective and its relationship to the content. Some of the areas of consideration for this proposed specification and XML binding might include, but would not be limited to the following (as previously defined in the Problem Definition section of this whitepaper):

- Learning objective statement structure (e.g. condition, behavior, standard, etc.), as described in the Navy's ILE specifications (2007)
- Learning objective types (e.g. terminal learning objective, enabling learning objective, etc.)
- Job, Task, Analysis information that the objective is based on (skills, tasks, etc.)
- The relationship of the learning objective to a defined competency (e.g. reference or linkage to the IEEE Reusable Competency Definitions (RCD) specification).
- Lifecycle of the objective (e.g. the objective is versioned & referenced by a persistent identifier so that other versions of the objective can be effectively managed).

Providing an XML binding to represent the data structures associated with the various aspects of a learning objective would promote reusability, reduce redundant content development efforts, and provide the stage for learning objectives to exist in an ecosystem of competencies and learning content. Currently, the Navy and other organizations are using proprietary approaches to create and manage learning objectives and other competency-related data. However, if a learning objective specification were available then content that was developed to satisfy the same learning objective as well as the learning objective data itself could be more easily shared across various learning content repositories and learning systems.

For any learning content, whether it's an objective, aggregation, or SCO, there is a crucial need for more than just basic metadata, but also for defining the deeper relationships upon which a content object is based (e.g. competencies). The need for a learning objective specification is not applicable to simple SCORM

content that does not contain a structured instructional strategy or composition. An example of simple SCORM content would be a PowerPoint presentation that was published as SCORM package simply for LMS distribution only.

A possible alternate solution to creating a new specification for learning objectives might include utilizing and extending the IEEE LOM and SCORM Content Aggregation Model (CAM) specifically for learning objective data as follows:

- Treat an objective as any other "resource" in the manifest. The objective could be included as an asset. If the objective is defined as a resource in manifest and utilizing the IEEE LOM, the following approach could be used for metadata associated only with learning objectives:
  a. The <general> element is used to provide the unique ID for the object
  b. The <lifecycle> element is used to provide the version of the object
  c. The <relation> element is used to provide the persistent ID of the object so that the object can be "tracked" in relation to the other versions of the same object

The solution sets proposed in this section are not uniquely applicable only to the US Navy. Learning objective versioning and configuration control would be necessary for any organization attempting to utilize SCORM to promote both reusability and competency-driven content across their learning enterprise. Unique and persistent identifiers for learning objectives are a logical requirement to avoiding objective collisions. In addition, new specifications and/or extending the IEEE LOM and SCORM CAM would also be needed to fully support learning objectives and their full potential in SCORM. Without these specifications relating to learning objectives, organizations will begin or continue to create proprietary tools and specifications to achieve the functionality described in this section.

EXISTING IMPLEMENTATIONS

Figure 8 provides an overview of the learning content development and maintenance process currently being utilized by some communities within the Navy. This generic process flow illustrates how the Navy is addressing challenges with the life cycle management of learning objectives described in the preceding sections, and provides context for the specific prototyped tools and projects described in the following paragraphs.

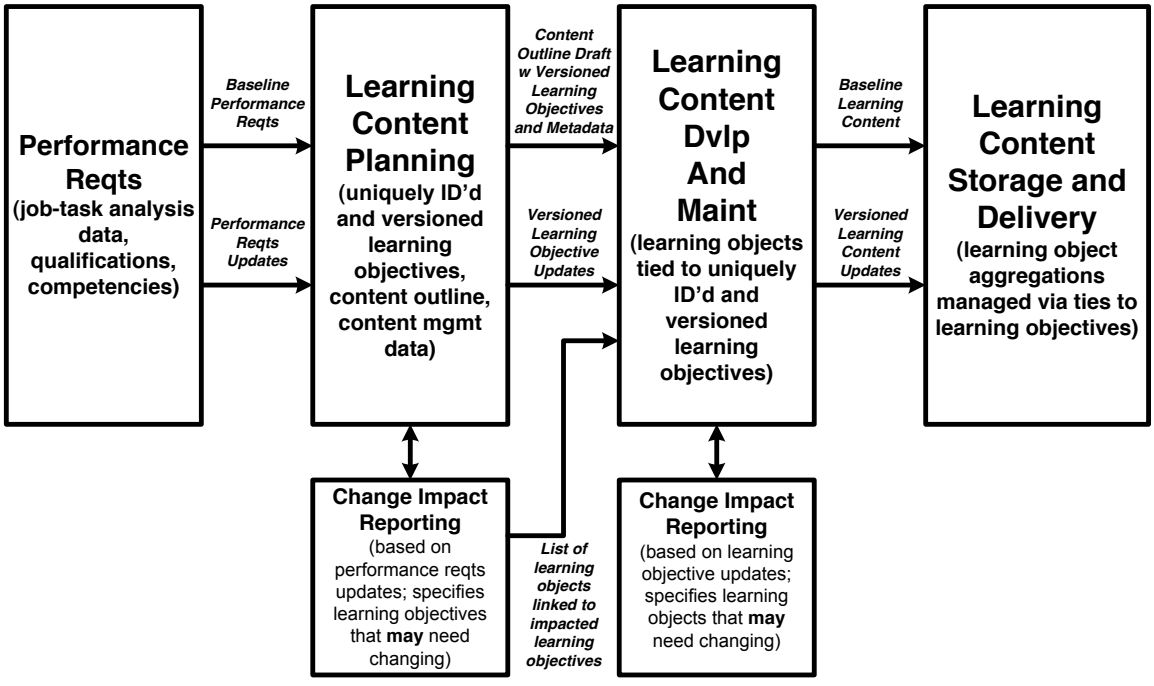

Figure 8: Navy Learning Content Development/Maintenance Process Overview

The Content Planning Module (CPM) is a government-off-the-shelf (GOTS) content planning application that maps a given job's performance data (job analysis/ skills data) to learning objectives. Performance requirements are available within CPM for Navy Learning Centers to begin linking learning objectives developed in conjunction with new learning content projects. CPM automatically assigns Unique Identifiers (UIDs) to performance requirements. The UIDs are included in the metadata of the CPM SCORM 2004 output package of the performance requirement basis, learning objectives, and course outline of instruction. When a performance requirement or skill is updated, their corresponding UIDs are the links that identify applicable learning objectives that might be affected. The automatic identification process results in flagging of the material and eliminating the traditional manual approach of searching through content. The AIM Learning Object Module is a related GOTS learning content authoring tool that uses the CPM SCORM package as the basis for building learning content tied to learning objective statements and performance requirement data. The LO Module learning content is tied to the learning objective statement performance requirement UIDs through metadata for the purposes of reusability, repurposing, reference, surveillance, and maintenance. The LO Module SCORM learning content package can be uploaded to an LMS for delivery to a student that will track completion of a learning objective by using the objective UID.

These tools have used SCORM 2004 standards for tool interoperability, and could easily be modified to test prototypes created in support of new standards developed as part of the SCORM 2.0 effort.

Various US Navy prototype projects currently illustrate this development process of mapping performance requirement data to learning objective statements to curriculum development. One of these prototypes, "AIM LO Module User" Training, began in Apr 08 using CPM as the Front End Analysis tool for capturing performance requirements of a curriculum developer. A content outline was developed in CPM tying curriculum developer skills data to learning objectives using CPM-automatically generated UIDs. The content outline was exported as a SCORM 2004 package from CPM to the AIM LO Module as the basis for developing learning content tied to the skills data and learning objectives. Once the learning content was complete, a SCORM package was generated from the AIM LO Module and loaded into the Navy's LMS for delivery to students. Similar ongoing prototypes could be used in support of testing the SCORM 2.0 effort.

Another prototype project in process is the Missile Technician (MT) Continuum (career-long learning progression for technicians operating and maintaining the TRIDENT ballistic missile systems). The MT jobs have been recently reanalyzed to identify competency-oriented skills. From this skills data, learning objective statements were developed and tied to the skills in CPM, and a content outline was developed. Learning content tied to the learning objective statements and subsequently the skills data is in the process of being developed. As the strategic weapons system (SWS) operated by the MTs undergoes its next modification, the skills for the new system modification will need to be analyzed. It is expected that many of the competency-based skills will remain the same, but some will require revision, deletion, and/or additions. Also, much of the knowledge data behind the maintenance and operation actions will require an update. As such, some learning objective statements will need to be changed to a new version while many will remain the same. As the learning content is updated for the new system modification, it is important to tie that learning content back to either the original or modified learning objective statements. This is to ensure that a Sailor who has completed the original training content tied to a particular learning objective statement is only required to take the training material related to those items that required modification in the new system configuration. With global learning objective possessing unique id and persistent id + version, this can be accomplished by loading the new content aggregation/course into the LMS. Since all material that relates to the original material will have ties to the learning objective statement with the original unique id, then that material will be marked as complete. Only material that represents new or changed knowledge and skills will be required to be completed. As such, the process of creating a conversion pipeline for a system modification is greatly simplified.

SUMMARY

One of the most positive features of SCORM 2004 is its potential for competency-based delivery of training. Ensuring that specifications are in place in SCORM 2.0 that adequately allow for learning objectives to be managed as they span various content development projects will allow new and existing learning applications, repositories, and business processes to more effectively work together.

Currently, the Navy is using CPM to manage learning objectives but this approach is not standardized across industry, DoD, or even the Navy. Although it is movement in the right direction and represents real working code that is achieving needed capability for the Navy, it is not globally applicable or usable without globally recognized and accepted specifications related to the gap it fills. The proposed UID specification and XML binding or IEEE LOM/SCORM CAM extension described in this white paper are needed for SCORM 2.0 so that applications like CPM, associated learning management systems, learning content, and competency repositories could all share learning objective data in an interoperable way. If these additions are not included in SCORM 2.0, it will continue to be difficult for organizations to most efficiently achieve their goals of competency-based learning and reusability of SCORM-conformant content. It is the hope of the authors that the LETSI committee will consider these proposed specifications for learning objectives as being critically needed inclusions to SCORM 2.0.

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